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MOVABLE BUSHING FOR A PRESSURE-LOADED GEAR PUMP

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2 Sheets-Sheet 1

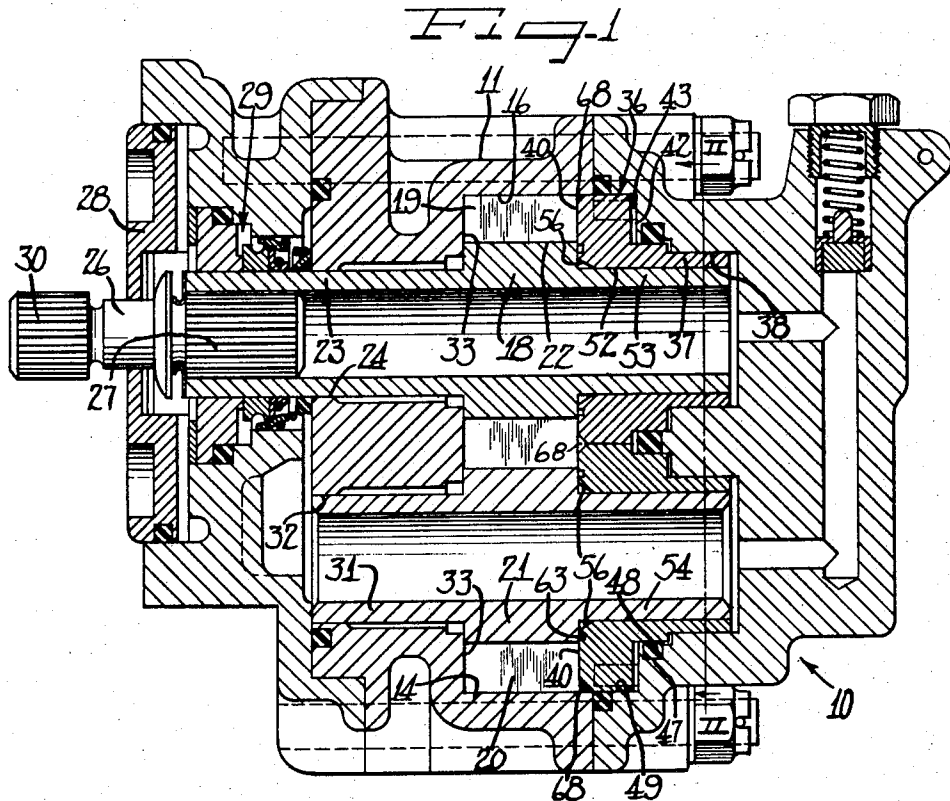
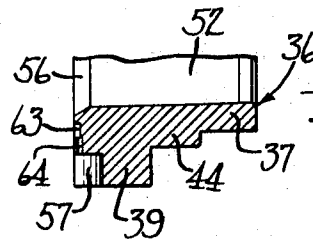
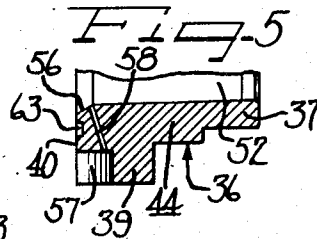
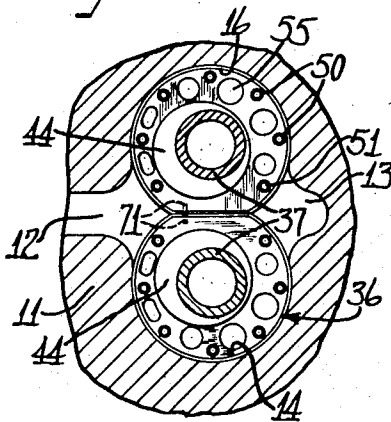


FIG-2



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2 Sheets-Sheet 2

Fig. 3

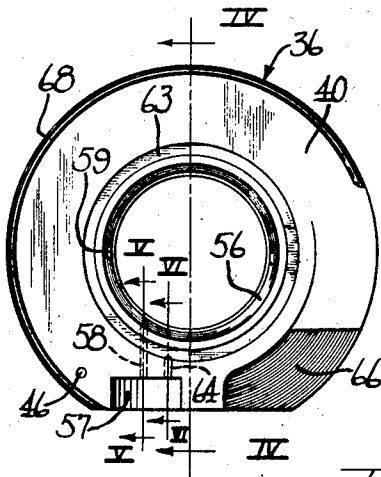


Fig. 4

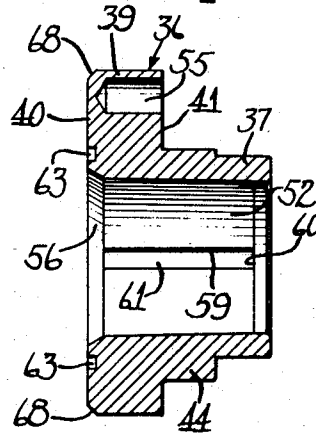


Fig. 7

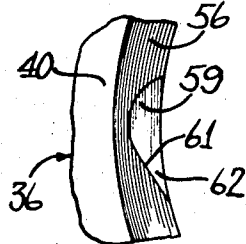


Fig. 8

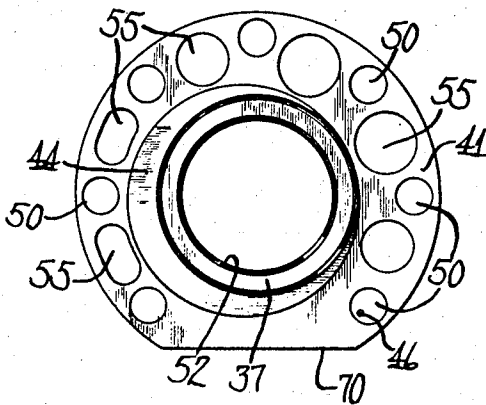
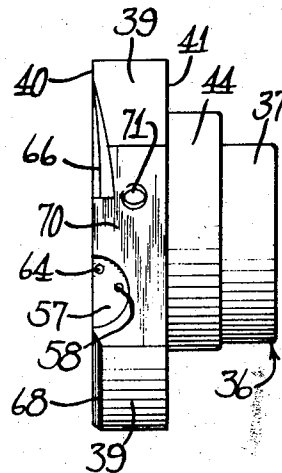


Fig. 9



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1

2,870,720

MOVABLE BUSHING FOR A PRESSURE-LOADED GEAR PUMP

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3 Claims. (Cl. 103—126)

This invention relates generally to pumps and more particularly to an improved movable bushing for a pressure-loaded gear pump.

Figure 1 is a cross-sectional view of a pressure loaded gear pump incorporating the movable bushings provided in accordance with the principles of the present invention;

Figure 2 is a fragmentary cross-sectional view with parts removed for the sake of clarity showing additional details of structure as seen generally on line II—II of Figure 1;

Figure 3 is an elevational view of the movable bushing of the present invention;

Figure 4 is a cross-sectional view taken generally on line IV—IV of Figure 3;

Figure 5 is a fragmentary cross-sectional view taken generally on line V—V of Figure 3;

Figure 6 is a fragmentary cross-sectional view taken generally on line VI—VI of Figure 3;

Figure 7 is a fragmentary enlarged view showing additional details of construction of the groove illustrated in Figure 3;

Figure 8 is a rear elevational view of the bushing shown in Figure 3; and

Figure 9 is a bottom plan view of the bushing of Figure 3.

As shown on the drawings:

The principles of the present invention are illustrated in connection with a pump indicated generally at 10 and including a housing 11 made up of a plurality of fastened-together casing sections shaped to provide an inlet 12 and an outlet 13 on opposite sides of a pair of intersecting bores 14 and 16 together forming a pumping cavity in which is rotated a rotary fluid displacement means.

In the embodiment illustrated, the rotary fluid-displacement means comprise a driver gear 18 having a plurality of circumferentially spaced teeth 19 meshing with a corresponding plurality of circumferentially spaced teeth 20 of a driven gear 21. The teeth 19 and 20 have a root diameter indicated at 22 and each adjoining pair of teeth provides a space or pocket therebetween for carrying fluid from the inlet 12 to the outlet 13 whereupon the fluid is positively displaced upon intermesh of the teeth 19 and 20 on the discharge side of the pump.

The driver gear 18 has a gear shaft extension 23 which is journaled in a bearing surface 24 formed in the housing 11. A driving member 26 is splined as at 27 to the gear shaft extension 23. The driving member 26 extends outwardly of the housing 11 through a cover member 28. The usual seal and thrust assembly indicated generally at 29 is employed to prevent leakage outwardly of the pump 10. The driving member 26 has a splined portion 30 adapted to effect a connection with a suitable source of power.

The driven gear 21 is also provided with a gear shaft extension 31 journaled in a bearing surface 32 formed

2

in the housing 11. The housing 11 also provides a radially extending sealing surface 33 for engaging and sealing against an adjoining side face of the driver gear 18 and the driven gear 21.

On the opposite side of the gears 18 and 21, the housing 11 is bored and counterbored to receive the movable bushings provided in accordance with the principles of the present invention. One bushing is provided for each corresponding gear 18 and 21, however, because of the similarities in construction, only one bushing will be described in detail, it being understood that the structural features described are common to both of the bushings.

Thus, the movable bushing of the present invention is indicated generally at 36 and constitutes a generally cylindrical tubular member having a tubular extension 37 received in a bore 38 formed in the housing 11. At the end of the tubular extension 37 is provided a radially outwardly extending flange 39 providing a sealing front face 40 for engaging and sealing against the adjoining side face of a corresponding driver gear 18 or driven gear 21 and a pressure-receiving back surface 41 which is spaced from an adjoining wall 42 of the housing 11, thereby to form together with means including a portion of the housing 11 a pressure control chamber 43.

An annular radially outwardly extending shoulder 44 interrupts the peripheral surface of the tubular extension 37 adjacent the flange 39, thereby to proportionately decrease the effective pressure-receiving area of the pressure-receiving surface 41 towards the inlet side of the pump for balancing unequal pressure forces in the pumping cavity. Fluid at pressure generated by the pump 10 is communicated to the pressure control chamber 43 through a fluid passageway 46 extending axially or longitudinally through the flange 39 and communicating the outlet 13 of the pump 10 with the pressure control chamber 43.

The housing 11 is grooved as at 47 to receive a sealing member 48 which engages against the peripheral surface of the shoulder 44 eccentrically offset towards the inlet side of the pump. Accordingly, the diameters of the tubular extension 37 and the flange 39 remain concentric as do the corresponding diameters of the bore 38 receiving the tubular extension 37 and a bore 49 receiving the flange 39. Any manufacturing tolerances in connection with the eccentricity of the shoulder 44 are accommodated by the sealing member 48.

To initially load the movable bushings 36 into sealing engagement with the corresponding gears, the pressure-receiving back surface 41 is provided with a plurality of circumferentially spaced recesses 50 each bottoming a coil spring 51 and engaged against the wall 42 for exerting a continuous biasing force on the movable bushing 36 in the direction of the adjoining gear side face.

The pressure-receiving surface 41 of the bushing 36 is also characterized by the formation therein of a plurality of lightening recesses 55, thereby to decrease the overall weight of the bushing construction.

Each bushing 36 has formed therein a bore forming a bearing surface 52 for journaling a gear shaft extension indicated at 53 on the driver gear 18 and at 54 on the driven gear 21.

In pumping fluid, the load which is imposed upon the gears 18 and 21 is transmitted to a portion of the assembly corresponding to the center of a beam support. Accordingly, the stress concentrations which are present in the pump 10 produce a deflection of the beam. Additionally, there may be some tendency to a slight misalignment in end-to-end direction. The bearing surfaces which are provided at 52, 53 and at 52, 54 are provided with a

taper in the direction of the adjoining gear side face, thereby providing a gradually increasing clearance space along the length of the gear shaft extensions of the corresponding gears 18 and 21. There is thus provided a clearance space which is generally annular in configuration and somewhat conical, having its widest opening at the inner portion of the support. By virtue of such provision, load concentration is reduced at the inner portion of the supporting member and the clearance space thus provided facilitates the introduction of coolant and lubricant into the journal surface and greatly facilitates the dissipation of thermal energy.

In accordance with the principles of the present invention, the bearing surface 52 terminates at the sealing front surface 40 in a chamfered recess 56 which is formed at such a relatively sharp angle of taper relative to the angle of taper of the bearing surface 52 or the adjoining surfaces on the gear shaft extensions 53 and 54 as to completely remove bearing load on the bushing 36 immediately adjacent the sealing front surface 40.

Means are provided to communicate the chamfered recess 56 in pressure-flow relation with the outlet 13 of the pump 10, thereby to supply at increased pressure for cooling and lubricating the bearing surface 52. In the form of the invention illustrated, the sealing front face 40 has formed therein a trapping relief recess 57 opposite the adjoining gear teeth 19 and 20 of the driver and driven gears 18 and 21, respectively, and on the discharge side of the bushing 36. The trapping relief 57 prevents fluid from becoming trapped at the area of intermesh and is subject to full outlet pressure. As is clearly illustrated in Figures 5 and 3, a drilled passageway 58 intersecting the trapping relief recess 57 and the chamfered recess 56 communicates fluid at outlet pressure to the chamfered recess 56, thereby supplying coolant and lubricant to the bearing surface 52.

To further assist in flooding the bearing surface 52 with coolant and lubricant, a longitudinal groove 59 is formed in the bearing surface 52 and extends inwardly from the chamfered recess 56 terminating as at 60 short of the end of bearing surface 52.

The shape of the recess 59 is more specifically illustrated in the enlarged sectional view of Figure 7. It will be noted that the groove 59 is generally semicylindrical in configuration when viewed in cross-section and is particularly characterized, according to the principles of the present invention, by a tapered trailing edge 61 which together with an adjoining surface of a gear shaft extension 53 or 54 forms a convergent throat 62 converging in the direction of relative rotation between the adjoining bearing surfaces. It is well known that lubrication of a bearing surface journaling a relatively rotatable member is effected by the formation of a fluid film between the surfaces. Thus, the groove 59 operates as a reservoir and the convergent throat 62 functions to carry a supply of fluid from the reservoir into the fluid film formed between the adjoining relatively rotatable surfaces.

In operation, the sealing front surface 40 engages the adjoining side face of a corresponding gear and seals the fluid in the spaces between the gear teeth 19 and 20 so that the fluid being pumped will be carried by the spaces or pockets from the inlet 12 to the outlet 13. The sealing surface 40, however, extends radially inwardly a considerable distance beyond the root diameter 22 of the gears 18 and 21 and, accordingly, there is a direct metal-to-metal contact between the surface 40 and the adjoining gear side face.

In accordance with the principles of the present invention, the front sealing surface 40 is particularly characterized by the formation therein of a circumferentially extending continuous annular groove 63 which is located radially outwardly of the chamfered recess 56 but radially inwardly of the root diameter 22 of the gear teeth 19 and 20. The groove 63 is placed in pressure communication with the outlet 13 of the pump 10 by means of a drill

passageway 64 which intersects the grooved recess 63 and the trapping relief recess 57 as is clearly shown in Figures 3 and 6. There is thus provided a pocket of fluid which is localized in the area between the root diameter of the gear teeth and chamfered recess 56 which acts between the adjoining gear side face and the sealing surface 40. This localized pocket of pressurized fluid not only operates as a buffer to prevent binding and seizure between the gears and the bushings but also materially assists in heat dissipation.

The sealing surface 40 is further characterized by the formation therein of a filling recess 66 which is located outwardly of the root diameter of the gear teeth and opposite the gear teeth to assist in filling the spaces between the gear teeth with fluid at inlet pressure.

According to the principles of the present invention, the sealing surface 40 is further characterized by the provision of a chamfered peripheral edge indicated at 68 on the outer peripheral edge of the bushing 36, as indicated in Figure 3, thereby to form a circumferentially extending passageway which communicates the outlet of the pump with the spaces between the gear teeth and which extends through approximately 150 through 160° on each bushing 36, thereby terminating short of the inlet side of the bushing 36. The passageway formed by the chamfered edge 68 communicates the spaces between the gear teeth and tends to even out the distribution of pressure load acting on each bushing 36.

Each flange 39 of each bushing 36 is generally circular, however, a flattened chordal portion 70 is provided so that a pair of bushings, as shown in Figure 2 abut one another at the chordal sections 70, 70. A pin recess 71 is formed as indicated at 71 by means of which a pair of adjacent bushings 36 are locked against relative displacement when assembled in a pump.

Although various minor structural modifications might be suggested by those versed in the art, it should be understood that I wish to embody within the scope of the patent warranted hereon all such modifications as reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. In a high pressure gear pump, a housing having an inlet and an outlet and providing a pumping cavity, and end plate means for said cavity in said housing, said end plate means having a pressure-receiving back surface forming together with means including a portion of said housing a pressure-control chamber, said end plate means having a pressure-sealing front surface for engaging an adjoining side face of a rotary gear fluid displacement means, and means placing said pressure control chamber in pressure communication with said outlet, said sealing front surface having a chamfered peripheral edge forming a passageway extending from the outlet side of said end plate means around the periphery and terminating short of the inlet side of said end plate means to intercommunicate the spaces between the gear teeth and the pump outlet.

2. In a high pressure gear pump, a housing having an inlet and an outlet and providing a pumping cavity, and end plate means for said cavity in said housing having a pressure-sealing front surface for engaging an adjoining side face of a rotary gear fluid displacement means, the outer peripheral edge of said front surface being chamfered to form a circumferential passage extending from said outlet and terminating short of said inlet thereby to pressure-communicate the outlet with the spaces between the gear teeth adjacent said circumferential passage.

3. In a pump, a rotatable impeller having axially spaced bearing surfaces on opposite sides of a point of load concentration, bearing means including a bushing on one side of said point of load concentration providing bearing surfaces for beam support and journaling of said impeller at its bearing surfaces, and a taper

5

formed in said bearing surface of said bushing forming diverging clearance spaces extending towards the impeller to reduce center load concentration, said taper terminating in a chamfered recess adjacent said impeller to remove locally bearing load on said bearing surface and means communicating fluid at pressure generated by the pump to said chamfered recess for flooding the bearing surface with coolant and lubricant, said bearing surface having a longitudinal groove extending inwardly from said chamfered recess, said groove being particularly characterized by the formation therein of a chamfered edge to provide a tapered lead-in throat converging in the direction of relative rotation of the adjoining surfaces for assisting the introduction of fluid into the film between the adjoining journaling surfaces. 15

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